20/13

The Mysore Coffee Experiment Station—Bulletin No. 7.

DEPARTMENT OF AGRICULTURE

MYSORE STATE

ANNUAL REPORT OF THE COFFEE SCIENTIFIC OFFICER, 1931-32

BY

W. WILSON MAYNE, B.Sc.

Scientific Officer to the United Planters' Association of Southern India

BANGALORE:
PRINTED AT THE GOVERNMENT PRESS
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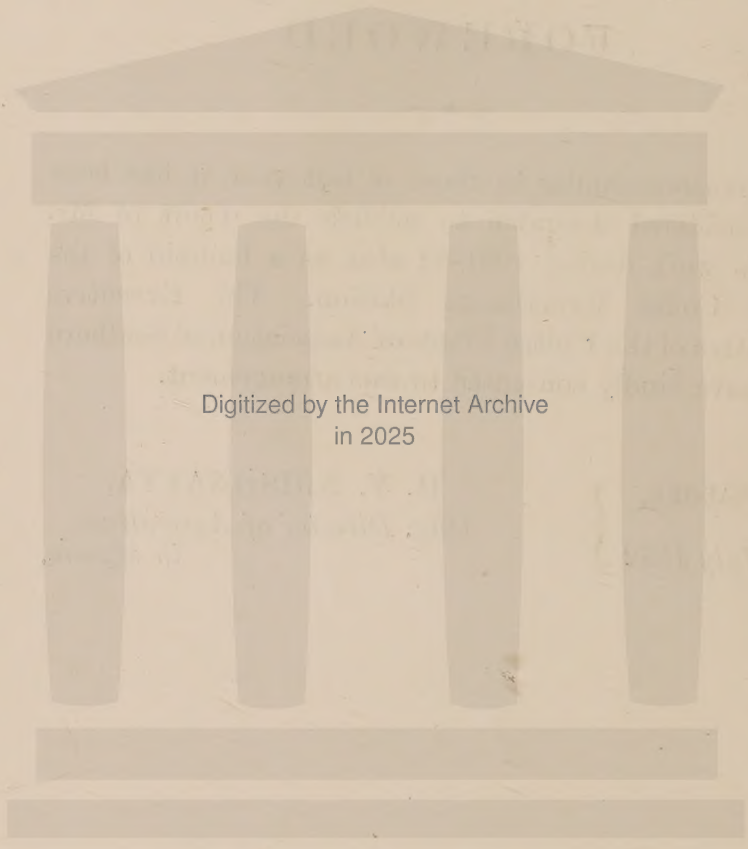
FOREWORD

FOR reasons similar to those of last year, it has been considered desirable to publish the report of Mr. Mayne's work during 1931-32 also, as a bulletin of the Mysore Coffee Experiment Station. The Executive Committee of the United Planters' Association of Southern India have kindly consented to this arrangement.

BANGALORE,
20th July 1932

H. V. KRISHNAYYA,
Offg. *Director of Agriculture in Mysore.*



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ANNUAL ADMINISTRATION REPORT OF THE COFFEE SCIENTIFIC OFFICER, 1931-32.

I have the honour to present the administration report of the Coffee Scientific Officer for the year ending 31st March 1932, dealing with the work in progress in connection with coffee problems.

As in previous years, the work has been centered at the Mysore Government Coffee Experiment Station, Balehonnur, under the direction of Dr. L. C. Coleman. Work in co-operation with the officers at the Station has been continued in connection with breeding, spraying and miscellaneous problems.

In November 1931, it was decided to employ an Indian assistant to work on the problems of Mealy Bug and Cockchafer in S. Coorg. Mr. V. K. Subrahmanyam, B.Sc. was appointed to the post at the commencement of December and after six weeks training in the Entomological Section of the Mysore Department of Agriculture, Bangalore, took up his duties in S. Coorg, with headquarters at the former Coffee Experiment Station at Siddapur.

The report comprises, as usual, a short account of touring work, scientific investigations in progress and general notes on coffee problems which have been raised during the year.

Touring.—Two periods of absence from headquarters have been occupied with visits to other districts. A period of one month in July 1931 was spent in S. Coorg in connection with Mealy Bug and Cockchafer the work of which will be considered under that heading later in the report.

In January 1932, a further period of one week was spent in S. Coorg in order to lay down lines of work for the Entomological Assistant. Following this, a short visit was paid to the Nilgiri-Wynaad to investigate an obscure root disease reported from an estate in that district. A report embodying the results of the investigation was prepared and despatched to the estate in question. The

points of general interest in connection with this root disease will be considered in the section dealing with root diseases.

Investigations.

Leaf Disease—Progress Report.—Considerable time has been occupied during the year with investigations directed to increase the available information on the life history, mode of infection and distribution of Leaf Disease (*Hemileia vastatrix Berk. and Br.*) and of the phenomena of resistance shown by various individual plants and strains. In some directions, progress has been satisfactory; in others, certain preliminary difficulties have not yet been completely overcome. The work falls into four parts—spore germination, infection, spore distribution and phenomena of resistance and susceptibility. In addition, evidence from field observations undertaken for studies of spraying and fruit loss has helped to shed further light on the problems of the rise and fall of attacks.

1. *Spore Germination.*—The germination of the Leaf Disease fungus spore is the first step in the development of a Leaf Disease spot and it is also the period during which the fungus is most vulnerable to direct measures of control. It will, therefore, be clear that an understanding of the process and the factors which influence it is of very considerable importance in increasing our control over the disease.

Most of the time up to date has been occupied with elaborating suitable technical methods of studying germination under various conditions. Increasingly more satisfactory results have been obtained, but even yet they leave much to be desired. Until the methods are sufficiently accurate to provide similar results in experiments carried out under similar conditions, it is not possible to study the effect of varying the conditions and so far this requirement has not been realized. The following figures illustrate the difficulty. These (Table I) are the percentage germinations found in 12 drops of distilled water containing spores which had been preserved in tubes for four days. The drops were distributed on four glass slides, each enclosed in a small closed dish. The conditions in each dish were considered to be identical as to humidity and temperature and all the glass ware had been cleaned and sterilized in the same way. The spores were all collected

from the same infected leaf from spots of approximately the same age by allowing the ripe spores to drop on a sheet of white paper.

TABLE I.

Percentage germination of Hemileia spores preserved for four days.—

Slide.	Percentage germination	Slide.	Percentage germination
Slide 1.	22·5 per cent	Slide 3.	18·3 per cent
	22·5 ,,		21·5 ,,
	17·0 ,,		25·8 ,,
Slide 2.	34·8 ,,	Slide 4.	44.0 ,,
	48·3 ,,		33·5 ,,
	37·3 ,,		42·0 ,,

It will be seen that the degree of variation is very high, ranging from 17·0 per cent to 48·3 per cent. It is to be noted that drops on the same slide show fairly close correspondence except in the case of slide 2, and that the slides 1 and 3 correspond fairly well as also do slides 2 and 4. This suggests that there is some factor of variation between slides or the dishes enclosing them which has upsetting results, and so far this factor has eluded detection.

In spite of these difficulties, information of a fairly definite character has been obtained on two points in connection with the germination of *Hemileia* spores. These two points have a direct bearing on field problems.

The first point concerns moisture conditions for germination. It has been found that germination does not occur in the absence of liquid water, but that actual submersion in water has a depressing effect on the development of germ tubes. The most favourable conditions are provided when dry spores are dusted on to drops of water. This has an interesting bearing on the view expressed in the reports on the Seasonal Periodicity of Coffee Leaf Disease (Mysore Coffee Experimental Station Bulletins 4 and 6, 1930 and 1931) that the rate of increase of the disease is retarded under heavy rainfall conditions. Under such conditions, spores would soon be waterlogged and therefore in an unfavourable condition for germination and this,

together with the washing effect of heavy and continuous precipitation would account for the behaviour already deduced from field observations.

The second point concerns the effect of light. It has been found that light has an inhibitory action on germination. The figures for two experiments given in Table II illustrate this point.

Experiment 1 was carried out with drops of water inoculated with spores on leaf surfaces from which the drops were afterwards removed to slides and counts made. Experiment 2 was carried out on glass slides. Similar results were obtained in other experiments. In these experiments, dry spores were dusted on to drops of distilled water.

TABLE II.

Effect of light on the Germination of Hemileia Spores.—

Experiment	percentage germination.	No. of drops examined
1. Light (N. window)	0·0 per cent	4
,, ,,	0·0 ,,	4
Darkness ...	16·3 ,, (mean)	6
,,	14·5 ,, ,,	4
2. Light (N. window)	2·0 ,, ,,	3
,, ,,	1·2 ,, ,,	3
Darkness ...	49·2 ,, ,,	3
,,	38·1 ,, ,,	3

This effect of light is at variance with most of the previously recorded work on the germination of rust spores but is in agreement with some results recently recorded by Dillon Weston for the spores of Black Stem Rust of wheat.

The problem requires much further investigation and work is planned to study the bearing of this laboratory discovery on the behaviour under natural conditions.

It at once focusses attention on night times as the period of spore germination. It does not seem to have much bearing on the question of shade, however. All the

experiments so far done have been under light conditions from a N. window, but some evidence from inoculation experiments suggests that diffuse light has not the same inhibitory effect.

The possibility of conditions favourable for infection being best realized at night and the results of experiments on the moisture requirements for germination served to indicate the highly favourable conditions presented by heavy morning dew. This commences in darkness and provides more efficiently than any shower of rain, a covering of innumerable fine drops of water over both surfaces of the leaf.

Judging by general observations in the field, the amount of heavy mists and dew occurring during the rainless months determines, to a great degree, the severity of the annual Leaf Disease attacks.

A large number of experiments undertaken to study the effect of short periods of storage of spores on their ability to germinate gave doubtful results for the reasons already described. There is some suggestion that a short period of storage of spores, sufficiently mature to fall from leaves kept in still air, results in better germination than is given by spores placed directly on water drops after detachment from the leaf.

Attempts to estimate the length of time which spores would retain their ability to germinate were commenced but beyond the fact that two collections kept in sealed tubes at laboratory temperatures and medium humidity gave no germination after six weeks, no reliable results have been obtained as to the limits.

2. *Infection of Coffee Leaves by Hemileia vastatrix.*— References in earlier reports to experiments on artificial inoculations of Leaf Disease were all records of failure, but during 1931, successful results were obtained and a technique of inoculation worked out. It is now possible to obtain inoculations on detached coffee leaves and to retain such leaves healthy for periods up to two months, giving ample time for the complete cycle from spore to spore to be completed and to allow studies on the type of infection and amount of spore production to be made.

The failure of the early experiments must be attributed to ignorance of the part played by light in inhibiting germination of spores and to insufficient control of the acidity of the water used for the inoculation drops.

The results so far obtained are of considerable interest but there remains a wide range of doubtful points which require clearing up.

Considerable variation in the time required for the development of visible spots at the places of inoculation and for the commencement of spore production was found in various experiments. Even separate inoculations on the same leaf showed differences of several days in these respects. The judgment of these times, particularly those of the first appearance of pale spots, is very difficult as the number of successful penetrations per unit area influences visibility. Taking the results as a whole, it appears that from 7 to 12 days elapse between infection and the first appearance of a yellow spot and from 15 to 24 days between infection and the first appearance of spores. These figures refer to Coorg variety leaves infected with spores taken from Coorg leaves and the experiments were conducted under laboratory conditions of temperature under glass jars. Inoculation on susceptible Robusta leaves gave much longer periods for the development of a visible spot and of spores, a matter of some interest with respect to the future status of *Hemileia* as a disease of Robusta.

TABLE III.

Leaf Disease Infection Times.

Date	Leaves	Origin of Spores	First appearance of	
			Yellow spot	Spores
8-10-31	Coorg	Coorg	12 days	15 days
28-10-31	„	„	8 „	16 „
6-11-31	„	„	9 „	17 „
14-12-31	„	„	9 „	17 „
12—1-32	„	„	7 „	24 „
12—1-32	„	„	7 „	22 „
12—1-32	„	Robusta	7 „	24 „
12—1-32	Robusta	„	20 „	29 „
12—1-32	„	Coorg	20 „	35 „

Of the factors which may affect the times required for the appearance of infection and of spore production, the following will require consideration—temperature, age of leaf, humidity of the air during development and the density of infection. It must be noted that the later infections in Table III were carried out on more mature leaves than the earlier ones owing to the cessation of vegetative growth and the difficulty of obtaining more tender leaves.

It is considered that the first appearance of pale spots is an unreliable index of the rate of development, as it depends very greatly on the person examining the leaf. The first date of spore formation is a much more well defined point in the life history.

3. *Resistance and Susceptibility.*—The development of a method of obtaining infections in the laboratory opened up a wide field of work in investigating the behaviour of the numerous selections, hybrids and crosses which are available at the Experiment Station. Work along these lines was started in September and the results have been of great interest and importance in relation to the breeding and selection work.

The first experiments were carried out on a number of plants which had been previously selected for their vigour and disease resistance as suitable starting points in the development of improved strains. The first experiment included leaves from four highly resistant plants which showed no disease in the field, two moderately resistant plants with some disease and one common Coorg type. Four leaves from each tree were inoculated and kept in the laboratory and the reaction of the plants recorded. The spores used came from Coorg trees.

Two striking results were obtained. The leaves from the four highly resistant plants showed this character in the experiment, but there was ample evidence that their resistance did not depend on any inability of the fungus to penetrate, because in the areas inoculated minute pale yellow spots developed, similar in appearance to the initial yellow spots which appear on ordinary susceptible plants. These yellow spots did not develop any further and although the leaves were kept under observation for 32 days, no spore production took place. Within that period, the Coorg leaves had developed disease spots and produced spores. Similar results were obtained in a

second experiment carried out for confirmation. The study of the internal changes associated with the development of these abortive infections is to be taken up.

The second point arose from the results obtained with one of the two moderately susceptible trees. This set of leaves inoculated in the same way as the rest behaved like the completely resistant sets, although in the field the tree from which they came showed some development of ordinary spore producing disease spots. An experiment was at once started to study the result in more detail. Leaves from this tree—S. 5-30 in the Station records—were inoculated on one side of the midrib with spores collected from a Coorg tree, such as had been used in the previous experiment described and on the other side with spores from S. 5-30. A control series was started at the same time using leaves from a Coorg tree inoculated in the same way.

The Coorg leaves showed the development of typical disease spots on both sides of the midrib, *i.e.*, both collections of spores were equally capable of infecting the leaves. On the S. 5-30 leaves, however, only the side inoculated with spores collected from S. 5-30 leaves showed the development of spore producing disease spots. The side inoculated with spores collected from a Coorg tree failed to produce more than pale spots which never developed into spore-producing pustules. These results have been repeatedly confirmed for the selection S. 5-30. Similar results were obtained with a set of leaves from a Kent tree which was resistant to spores collected from a Coorg tree and susceptible to spores from infections found on the Kent. A further experiment in which leaves from this Kent tree were inoculated with spores collected from S. 5-30 and with spores from the Coorg revealed that the Kent behaved in the same way as S. 5-30 in its reaction to the different spore collections.

It is considered that these experiments establish the existence of two strains of *Hemileia vastatrix* which behave differently on certain strains of *Coffea arabica*.

There is a strong suggestion that this resistance to one strain is common among Kent's selection. S. 5-30, on which this behaviour was first found, is grown from seed of a plant in Woger estate which is related to Kent. Further, the results afford a basis for the explanation of features in the field behaviour of Kents which have

previously been inexplicable. An account of this work in relation to the behaviour of Kents has been prepared and will be published in the "Planters' Chronicle."

Much further work is required on this problem to investigate what proportion of Kent plants possesses this partial resistance and how it is inherited. There is also the possibility of still other strains of the disease, though no certain evidence has as yet been obtained of such. The leaf disease on the susceptible Robusta plants so far examined has not been detectable as a separate strain.

One experiment using spores from *Hemileia* infections on *Gardenia gummifera* and *Vangueria* (?) sp. failed to give infection on Coorg leaves.

Further work along these lines is planned for the future. The method of inoculation on detached leaves is to be used for studies on the resistance of the various crosses and self fertilized lines now being developed on the Station. The method will facilitate the elimination of types of high susceptibility to disease in the nursery with much saving of time and space in the field, and at the same time will throw light on the mode in which resistance of Leaf Disease is inherited.

Spore Distribution.—In order to study certain peculiarities of the development of Leaf Disease in areas exposed to and sheltered from wind, a number of glass slides smeared with vaseline were exposed as spore traps on posts erected in two areas of coffee near the Station towards the end of the S. W. monsoon. The slides were arranged so that equal numbers were exposed to each of the four cardinal points of the compass in each area. They were left exposed for one week and then collected and stored in clean slide boxes for microscopic examination. During the period, the wind was consistently in the W. or S. W. as is usual during the monsoon, where it is not changed by configuration of the land.

One area faced west and was exposed to the full force of the wind. The coffee was about five years old and the shade, light. The other area was sheltered from the wind with a gentle eastern slope. The coffee in this area was older and higher, and the shade thicker than in the first area. The status of the disease was markedly more severe in the latter area than in the former. In both places, the slide-bearing posts were about the same height, so that

they were well above the coffee in the first area and slightly above it in the second.

It is admitted that the two areas were very dissimilar in ways other than facing and wind exposure, and that direct comparisons between the number of spores caught are not possible. However, the counts actually made are of interest in connection with the movement of spores in the air. It is unfortunate that the number of slides examined is small, but the work of examination is extremely slow and occupies a great deal of time. The results are given in Table IV.

TABLE IV.

Leaf Disease Spores caught in Spore Traps.

Position of slides	Spores Caught			Average
	Slide 1	Slide 2	Slide 3	
W. (Exposed facing) ...	23	17	21	20·3
S. (,, ,,) ..	36*	6	4	15·3
N. (,, ,,) ...	5	13†	5	7·7
E. (,, ,,) ...	7	3	10	6·7
W. (Sheltered facing) ...	3	4	...	3·5
S. (,, ,,) ...	14	12	...	13·0
N. (,, ,,) ...	17	11	...	14·0
E. (,, ,,) ...	11	16	...	13·5

NOTE.—* 12 groups of spores. † 3 groups of spores.

The markedly greater number of spores caught on the slides facing W. in the series exposed in the windswept area affords interesting proof that the spores move with the wind. In the sheltered areas, there is no such definite movement, and all directions of exposure show a generally similar "catch" of spores except the slides facing West. The low numbers on the western facing in this area are very difficult to explain, unless it be that under the lee of the slope, there is a back eddy of wind from the East. This is not supported by the evidence of the slides facing East.

As has already been stated, the status of the disease was markedly higher in the sheltered area, though the spore-catches were barely as high as in the slides exposed to the west wind. This suggests that in sheltered situations the horizontal movement of spores is much less

marked than in windswept areas. Unfortunately, no data are as yet available with regard to downward movement.

The tentative conclusions drawn from the field observations of 1930 on the influence of wind exposure are supported by these spore trap observations (Seasonal Periodicity of Coffee Leaf Disease. Second Report. Bull. fig. 6. Mysore Government Coffee Experiment Station). In that report, it was suggested that the later development of Leaf Disease on windswept areas was due to the greater wastage of spores. The considerable horizontal movement of spores with the wind in the windswept areas would tend to carry spores rapidly through the air, resulting in wide diffusion of the spores and large losses of spores which would be carried into areas where coffee was absent —jungle, etc.

The possibility of using wind breaks on ridges to act as spore traps is one that, I think, might merit consideration, especially in areas where coffee is growing on two sides of N.—S. ridges.

General Observations on Leaf Disease.—The foregoing sections deal with specific work on Coffee Leaf Disease. In addition, various detached observations made in connection with other work serve to throw light on various aspects of the Leaf Disease problem. Cataloguing such detached notes would serve no purpose at present. Later, it is hoped to summarize all the available data, both observational and experimental, bearing on the development of the disease through the year and the effect of environmental conditions thereon.

Root Diseases.—Work on root diseases has been largely in abeyance. The wood block cultures of *Fomes lamaoensis* have been kept going and evidence of complete penetration obtained. Thin pieces of wood permeated by the fungus have been found to show the brittleness which is characteristic of the disease in the field. Microscopic examination of the wood failed to reveal any marked structural alterations and chemical tests for lignin revealed no apparent reduction in this constituent. Further work along these lines to investigate how the fungus brings about decay are planned but have been held up by other work of a more important nature.

Wood blocks heavily infected with pure cultures of the fungus were buried in contact with roots of young coffee trees growing in tubs. So far, no signs of attack

have been visible though the experiment has been in progress for six months.

Of other root diseases, *Rosellinia* remains secondary to Brown Root Disease, while two other types have come under notice during the year. The first of these has been found occasionally in patches in Mysore and in general characters resembles *Poria hypolateritia*, the Red Root Disease of tea, but it does not seem to be very common. The second is of some importance in the coffee near Gudalur. The characters are rather indefinite and no certain identification has been possible. Cultural work resulted in the isolation of a fungus which in its growth characters showed resemblances to *Fomes applanatus*, a fungus reported by Petch (Diseases of the Tea Bush) as occasionally causing root disease of tea in Ceylon. The same author mentions that it has been reported as a root disease of coffee in South India, but without reference to the authority. As the characters of the disease on the dead tree from which this isolation was made differed somewhat from those of other trees dug out, it is probable that other fungi are also involved.

The majority of the attacked trees showed very little external signs of disease, but on splitting the tap root the wood was discoloured and smelt "mushroomy." In the oldest stages, the wood was spongy and wet. The progress of the disease appeared to be slow as it was only occasionally that a patch of the disease was clearly noticeable. Close inspection revealed in many cases that where a single tree had died suddenly, there were indications of previous deaths in the presence of supplies several years old. In practically every case, a dead stump was present nearby and in one case the spread of disease along a large root of a dead stump to the dying coffee tree was established by careful excavation. In this case, the stump root showed a progressive decay from the dead stump outwards to a point where it was in direct contact with the tap root of the coffee.

Recommendations were made along the usual lines. There does not seem much prospect of any marked advance in the treatment of root diseases until the conditions under which dead stumps and felled logs decay in tropical soils are subjected to comprehensive investigation. An understanding of the succession of organisms involved in the process together with the place in that succession

taken by the few more important organisms involved in root diseases of the crops might provide data which would suggest means of directing that succession along lines unfavourable to the development of root disease fungi, or means of otherwise controlling decay.

Spraying Mixtures—Progress Report.—In the Administration Report for 1930-31, a series of observations made on plots receiving different types of spray mixtures was reported. These were designed to provide an estimate of the effect of the different mixtures in preventing leaf fall resulting from Leaf Disease. Observations of identical type were carried out at approximately the same time during the year under review. The results, together with those of 1930, are given in Table V.

TABLE V.

Effect of Different Sprays on Amount of Leaf held by Typical Branch Systems.

Mixture used	1930		1931	
	Order	Leaf count	Order	Leaf Count
Linseed Oil Bordeaux 10 ozs.	1	6·35±·21	1	6·28±·23
„ „ „ 40 ozs.	2	6·28±·25	7	5·77±·23
„ „ „ 20 ozs.	3	6·09±·19	2	6·23±·25
Casein Bordeaux ...	4	5·90±·18	3	6·19±·24
Fish Oil Resin Soap Burgundy	5	5·57±·23	8	5·66±·26
Resin Soda Bordeaux ...	6	5·50±·16	6	5·94±·20
Alum Bordeaux ...	7	5·38±·24	4	6·00±·28
Resin Soda Burgundy ...	8	4·87±·18	5	5·97±·21
Solbar 3 per cent ...	9	3·10±·11	9	5·12±·19
Check No. spray ...	10	2·40±·13	10	3·13±·17
Bordeaux without adhesive ...	No observation		...	5·40±·19

Taking the data as a whole, there is a general reduction in differences between the different treatments during the present year together with an improvement in the results of the check counts and the treatments which gave poorer results in 1930. This was to be expected as the weather conditions were considered less favourable

for the disease during the very wet monsoon of 1931. Conversely, the results afford an interesting confirmation of the depressing effect of heavy rainfall on Leaf Disease which was concluded from previous observations recorded in the bulletins on "Seasonal Periodicity of Coffee Leaf Disease."

Considering the individual spray mixtures, Linseed Bordeaux in the 10 oz. strength continues to head the list, while Linseed Bordeaux, 20 oz., Casein Bordeaux and Resin Bordeaux hold approximately the same positions as in 1930. Solbar shows again as the least effective. Experiments with this material have been abandoned. Alum Bordeaux and Resin Soda Burgundy show marked improvement in effectiveness, while for some unexplained reason Linseed Bordeaux 40 oz. exhibits a marked drop.

Further data will be required for providing results of definite statistical significance, but it seems probable that either Linseed Oil at the 10 oz. strength or Casein is likely to prove the best adhesives. The problem of the relative merits of Bordeaux and Burgundy mixtures must await further results, but the data obtained suggest that there is no advantage in the latter from the point of view of fungicidal power.

With regard to the use or disuse of adhesives, the results of 1931 suggest that there is a positive advantage to be gained by their use, the differences between the figures obtained with Casein and without being statistically significant. At the same time, the advantage to be gained by spraying without an adhesive as compared with no spray at all is considerable. It remains to be seen from crop yields whether the increment gained covers the cost of the adhesive. In view of the quite high figures for spraying without adhesive and of the fact that the monsoon of 1931 was an extremely heavy one, it seems that the omission of the adhesive in September—October spraying would not seriously affect efficiency of protection.

Time of Spraying and Strength of Spray—Progress Report.—Similar observations to those described in the previous section were carried out in September and in February on a series of large plots receiving spray applications at various times and in different strengths. The results are given in Table VI.

TABLE VI.

Effects of Spraying at Different Times and in different Strengths on Leaf held by Typical Branch Systems.

Treatment	Leaf Counts		Crop in lb.
	September 1931	February 1932	Cherry per 500 trees
1% May and September ...	6·55±·22	4·29±·17	1425 lb.
0·5% „ „ ...	6·17±·19	2·45±·12	2059 „
1% May only ...	6·39±·21	2·22±·14	1013 „
0·5% „ ...	6·82±·20	1·67±·16	809 „
1% September only ...	3·31±·21	2·38±·17	800 „
0·5% „ ...	3·34±·19	2·34±·15	852 „
Checks I ...	2·38±·19	0·95±·11	1829 „
„ II ...	2·94±·19	1·48±·13	1026 „
„ III ...	3·47±·23	1·70±·14	667 „

Unfortunately, the soil and shade conditions vary considerably through the area so that the results are somewhat difficult to interpret. The plots are arranged as follows: One per cent May and September spray, one per cent May spray only, 0·5 per cent May and September spray, 0·5 per cent May spray only, one per cent September spray only and 0·5 per cent September spray only, with check plots between the treatments. Figures are only given for three check plots near the centre of the whole series. The check plots were under treatment during 1930 and the effects of the treatments were still evident in 1931 so that the data are of limited value for this year. The high yields given by Checks I and II in the table are the results of the 1930 treatments to which they were subject.

It can be seen from the September observations that there is no significant difference between the one per cent (5-5-50) application and the 0·5 per cent ($2\frac{1}{2}$-$2\frac{1}{2}$-50) application. As might be suspected also, the September application, done only a few days before the observation was made, exerted no effect and the results do not differ significantly from Checks II and III. The poorer figures for Check I may probably be attributed to the very considerably heavier crop it was bearing as a result of the previous treatment.

The result of the February observations are more difficult to interpret as matters are greately complicated by difference in crop yield. Thus, it might be concluded from the significant difference in leaf amount in the two twice sprayed plots as indicated by the observational data that 0·5 per cent mixture was less efficient than one per cent. A reference to the crop yield figures shows that the 0·5 per cent twice sprayed area produced nearly 50 per cent more crop than the one per cent twice sprayed area and the greater leaf loss may be due to the heavier strain on the trees and not to any fungicidal deficiency of the mixture. In the case of the area sprayed only in September, there is no apparent difference in the effectiveness of the two strengths. In the case of the areas sprayed in May only, the 0·5 per cent strength does not seem to have been so effective as the one per cent strength and in this case no explanation based on crop differences is possible. It must be remembered that the heaviest intensity of the disease occurs usually in October and November and it is possible that the 0·5 per cent mixture applied only in May loses its efficiency by the washing of rain sufficient to result in a reduction in leaf amount below that of the trees sprayed with the one per cent mixture at the same time. More definite information on this point must await on further data.

The general course of the results is in agreement with earlier conclusions based on studies of the seasonal behaviour of Leaf Disease. Of the two sprays, the pre-monsoon application is to be regarded as the most important, while the post-monsoon application is secondary to it. It is possible, in wind-swept areas where the wide dissemination of spores retards the development of attacks, that a post-monsoon application alone might be of value, but the risks of failure are considerable.

The figures for crop yield in the areas receiving only one application do not reveal very clearly the greater role played by the pre-monsoon spray. A general inspection prior to the 1932 blossom revealed, however, that the pre-monsoon sprayed areas had formed very considerably more bud than the post-monsoon sprayed areas, so that although the crops from all four of the single sprayed plots were similar, there is every likelihood of a difference being visible in the next crop in favour of the pre-monsoon sprayed areas.

Work along these lines will be continued in the coming year both in September-October and February-March. The results which accumulate from year to year are being filed and taken with climatic data will afford in time a valuable body of material for advice on spraying questions.

Note on Tables V and VI.—The method of obtaining the figures given in the two tables was explained in the Annual Report for 1930-31, and in an article in the "Planters' Chronicle" of July 4, 1931, pp. 315-7. The fraction prefixed by the ± sign following each figure representing the estimate of the number of leaves per growing shoot is an estimate of the Standard Error which is used in arriving at significant differences.

Flower and Fruit Studies.

Pollen Germination.—Some further work on pollen germination was carried out during the year, but no further results of general interest have been obtained. This year's results seem to suggest a relationship between pollen viability and the atmospheric humidity at the time of flowering, but the results are a little conflicting. In view of the importance of this problem from the point of view of breeding work, it is hoped to arrange for the watering of trees in future seasons with the pollen problem in view, instead of using trees watered primarily for breeding purposes.

Floral Studies.—It was noted in the last report that a number of hybrid plants in the selection plots at the Experiment Station formed no pollen. Investigations made on immature buds showed that the condition of male sterility could be detected readily in January. The condition is associated with malformed anthers, the malformations varying from the absence of pollen sacs in normal shaped anthers to the complete replacement of anthers by petaloid structures. All degrees between these extremes could be found in different plants. The results were placed at the disposal of the Plant Breeding Assistant at the Experiment Station and, in co-operation with him, a large number of Station selections were examined.

Crop Losses during Development.—An announcement was made in the Annual Report of 1930-31 of a series of observations undertaken to investigate the times at which

developing fruit are lost. These observations were carried to a conclusion in December 1931 and a new similar series started in March 1932. A synopsis of the results is given in Table VII. It will be understood that one year's results are quite insufficient to draw any conclusions but in view of the results of the small scale observations of 1930, several points may be commented upon.

As in the observations of 1930, the major portion of the loss occurs in April, May and June. The subsequent losses are negligible and largely attributable to mechanical causes, though a reservation must be made with respect to "Jeloo," a subject which will be considered below.

TABLE VII.

Crop Losses during Development.

Times of loss	No	Percentage of original bud
Original flower bud 1-4-1931 ...	9031	.....
Loss 1.—between April 1st and May 5th.	1850	20·5 per cent
Loss 2.—Unswollen fruit distinguished on May 12th.	989	11·0 „
Loss 3.—between May 12th and June 16th.	2414	26·7 „
Loss 4.— „ June 16th and November 12th.	381	4·2 „
Fruit picked on November 12th ...	3397	37·6 „
Total ...	9031	100·0 per cent

The four sets of losses indicated in the table are clearly separable and form well defined groups, the causes of which remain uncertain.

Loss 1.—This loss is indicated as occurring between the blossoming on April 1st and May 5th, but, in fact more than half of it occurs in the first week after flowering. The affected young fruit initials turned yellow, dried up and fell from the fruiting nodes. In some cases, failure at this point involved whole groups of flowers, and may have been due to defective buds which failed to open normally. In great measure, this loss is probably to be considered as a failure to fertilize.

Loss 2.—This loss did not involve a fall of young fruit, and it is not possible to say when the conditions

giving rise to it originated. It is noted as occurring on May 12th because at this date it was possible to distinguish that a certain proportion of the young fruit was lagging behind in development. These fruit never developed to maturity, remaining only slightly larger than the original pistils present at the base of the flower at blossom time. They disappeared gradually during the course of the year, though a few were still to be found even at harvest. The reason for this failure of development is unknown and will have to be sought by other methods.

Loss 3.—This constitutes the largest single loss in development. Attention was drawn to it in the report of 1930-31, where in a small series of observations, about 11 per cent of the original blossom was affected.

It occurred very suddenly between the 2nd and 16th June in the year under review. The characters of the majority of the fruit falling at this time were the same as those described on page 13 of the annual report of 1930-31. Five hundred fallen fruits found at this period were examined and classified. It was found that 77 per cent showed the characters described-blackening of the bean tissue before the decay of the pulp and a development of white powdery material at the point at which the fruit broke away. Of the remainder, 10 per cent showed the development of the white powdery material at the base of the fruit or fruit stalk but without any decay of the bean tissue, while the rest 13 per cent—were characterized by the splitting of the pulp tissue at the base of the fruit without any other signs of decay. The first two types were all slightly smaller than the healthy fruit at the time of the fall but the last type consisted of fruit as large or larger than the healthy ones.

Attempts to isolate an organism from the fallen fruit were all failures. Microscopic examination failed to reveal any signs of infection in either the dark decaying bean tissue or the white powdery material at the base of the fruit or fruit stalk. This white powdery material was composed of cells which had become separated from one another by the dissolution of the material binding the cells of the tissue together.

All the indications point to physiological causes as the reasons for this fall. These causes will require fuller investigation in the future with special reference to the variation from year to year and the effect of varying environmental conditions on the amount affected. It is

hoped that closer examination of the data may throw more light on the problem, but the work of examination has not been completed.

Loss 4.—This small loss is mainly due to mechanical causes and to the dying back of one or two of the branches under observation. It must be remembered that the branches upon which these observations were made, were all sprayed twice, before and after the monsoon so that losses due to Leaf Disease and Black Rot were practically eliminated.

Taking the figures as a whole, it can be seen that 376 per cent of the original bud reached the stage of maturity in this series of observations.

The records were kept for each of the 96 branches which survived out of the original 100, four being lost by mechanical injury. From the data so recorded, two interesting points emerge.—

1. The branches with the largest number of buds gave lower percentage sets than those with a smaller number.

2. Branches with few leaves at blossom time were liable to large losses in the early stages of development while many leaved branches suffered but small losses. The correlation was by no means complete as some other branches with low numbers of leaves suffered small losses. No branches with large leaf numbers gave heavy early losses.

Examination of the Crop Picked.—The 3397 fruits picked were all cut open and the condition of the beans recorded. A synopsis of the results is given in Table VIII.

TABLE VIII.

Analysis of Fruit Picked in C yop Development Observations.

	Fruit	Percentage	Beans	Percentage
Total	3397	.....	6376	.....
Total Peaberry	451	13·3	451	7·1
Total three beans per cherry...	33	1·0	99	1·6
Total Empty beans ...	119	3·5	129	2·0
Total Black bean	478	14·1	757	11·9

This analysis provided several points of interest in connection with two defects of the final crop. These two are light or empty beans and black bean, both of which would be classed in practice as light or jeloo. It seems that the two are quite distinct.

The type described in the Table as empty beans are beans which contain no endosperm, *i.e.* the " meat " of the bean is absent, but are completely developed in size and have a normal parchment skin. The most striking feature of this defect is the rarity with which it affects a whole fruit. It can be seen from the Table tha', while 119 fruits contained such light beans, there were in all only 129 such beans, and as most of the affected fruit were normal ones it is obvious that the number in which both beans were affected was extremely small. No explanation of this peculiarity can be given at present but this phenomenon may also be due to some irregularity in the complex process of fertilization.

The second type of defect is " black bean ," a trouble which has come into considerable prominence during the last year. The defect consists of the replacement of the bean tissue by a dark-brown to black pulpy meterial which shrivels and dries in the later stages. One or both beans may be affected in a fruit. There are no definite external signs by which the trouble can be diagnosed, though some such fruits bear a few minute pale yellow spots on the surface of the outer skin. These spots however appear to be no more than superficial. In the present analysis, some beans are included among the black beans which are not completely decayed in the manner described, but showed decay or spotting only on a portion of the bean. Intermediate cases suggest that they all probably belong to the same group, but this statement may require some modification in the future. If there is a distinet class of abnormalities among the fruits classed as black bean, it makes up but a very small portion of the total.

The common feature is the absence of any external signs of decay on the fruit coupled with a partial or complete decay of one or both beans. The parchment skin is usually quite normal. The percentage of affected fruit in the collection was 14· fig. 1 per cent, a much lower figure than that reported from a large number of estates in various parts of South India during the year.

Black Bean—Progress Report.—As has been mentioned in preceding section, black bean was a serious and widely distributed defect of the crop of 1931. The first reports were received at the end of August and from that time onwards evidence was obtained of its presence in greater or less degree throughout the coffee districts of South India except the Shevaroys. It was reported from one or two estates in Mysore in 1930, but it was serious on only one and appeared then to be related to a severe attack of Leaf Disease.

A description of the trouble has already been given in connection with the crop loss observations. This description applies generally to all the specimens examined but there are one or two points which require fuller elucidation. At the Experiment Station and on estates in the vicinity, affected fruit did not fall from the tree although the presence of the trouble was established at the end of August. In the report from the Annamalais received in early September, however, mention was made of a heavy fall of fruit and specimens received of such fallen fruit revealed a high percentage of black bean. Where fruits did not fall, they failed to ripen and in many cases the presence of large amounts of the defective fruit was not realized until the time of stripping. In the few cases noted in 1930, the affected fruit appeared to ripen normally and bad vat outturns were obtained from the beginning of crop.

On obtaining the first reports in August 1931, an inspection was made of fruit samples collected in the area where the fruit loss observations were being carried out. Some 200 fruit were cut open and examined and the number of affected fruit recorded. The percentage worked out at about 12 per cent. An inspection of the figures obtained in November from the final crop of the branches under observation shows only an increase of about 2 per cent and this is as likely to be due to the errors of sampling as to any real difference in amount. As the periodic observations show no loss during the intervening period, it seems evident that the affection does not increase with time after September. As yet, there are no data available for earlier periods, so that we do not yet know at what time the condition is first initiated.

In order to see whether the condition could be attributed to Leaf Disease and Die Back, a number of

fruit were collected in September from branches which had lost all their leaves from Leaf Disease and were showing signs of Die Back. The amount of black bean was, if anything, rather lower than in fruits taken from healthy branches. It does not seem that Leaf Disease and Die Back have anything to do with the amount of black bean and this is borne out by its presence in quite as large amount on estates where these diseases are serious as on those where they are not.

Observations were then extended to the manuring plots and samples of fruit were collected from areas receiving Nitrogen alone (N) Phosphoric Acid alone (P), Potash alone (K), a complete manure (N+P+K) and no manure (Check). The samples were rather small and there are no data available to allow a decision to be made as to how far the differences recorded can be considered significant. However, the strikingly high figure for the samples taken in the plot receiving Nitrogen alone deserves closer investigation. The results are given in Table IX.

TABLE IX.

Manuring Tretment and Black Bean.

Treatment.	Percentage Black Bean.
No manure ...	5·4 per cent
N only ...	11·3 ,,
P only ...	4·9 ,,
K only ...	4·1 ,,
N+P+K ...	6·3 ,,

A large series of cultures were attempted to investigate the possibility of the presence of some parasitic organism. These all gave negative results, the only growths obtained being common saprophytic bacteria and fungi which occurred irregularly in the cultures. Examination of the dark bean tissue and the brown juicy liquid pressed out of them failed to reveal any signs of an organism.

Further work is required to provide an explanation of the trouble. So far, the evidence obtained is mainly of a negative character. It is apparently not the result of other diseases and does not seem to be the consequence of parasitic invasion of any sort. It is obviously a

disease of occasional occurrence. As far as it has been possible to trace, its last appearance in noticeable amount was in 1923. This suggests a connection with climatic conditions, but data are at present too meagre for any definite climatic causes to be assigned to the disease. It has been suggested that the heavy rain in August was responsible but in view of the presence of black bean in the 1930 crop in N. Mysore, this must remain doubtful, as 1930 was a year with an abnormally light monsoon rain. I am inclined to consider that the conditions leading up to black bean act earlier than the heavy monsoon rains. There is a suggestion in the data for the early crop losses recorded in the preceding section that there may be a relation between the early June loss and the amount of black bean, a heavy June loss being followed by a lesser amount of black bean and *vice versa.* This possibility has only recently come to light in the study of the data and it has not yet been possible to examine the question critically.

The data for the effect of manures on the incidence of black bean warrant further investigations of this question and it is hoped to take up this subject during the coming year. A study of fruit samples taken at regular intervals will also be made to see at what time differentiation of sound and unsound fruit is possible.

At present, it seems that the disease is the result of physiological disturbances probably connected with the supply of nutritive material under certain climatic conditions.

Mealy Bug and Cockchafer.—Work on Mealy Bug and Cockchafer commenced with preliminary survey in July 1931 and has been continued by the Assistant Entomologist from February 1932. At this early stage in the investigation, there can be but little to report. It seems however that the problem is extremely complex and involves a great deal more than the presence of certain specific insects.

The outstanding feature of the problem is the high mortality of supplies between the ages of one and four years. With this, mortality have been associated the two insect pests mentioned and the investigation is planned to find out what part these two insects play and in what way the high death rate can be prevented, or, at least, substantially reduced.

Mealy Bug (*Pseudococcus citri, Riss*) ?.—At the time of my visit in July, this pest was not serious and it was only towards the end of my visit that I was able to see any heavily infested plants. Judging by the time, these infested plants had been planted in the field and by the number and stage of development of the bugs, it seemed more than likely that the pest had been introduced with the plants from the nursery. This was supported by evidence given by a planter who stated that only in nurseries did this insect give him any trouble.

Later work has shown that Mealy Bug is ubiquitous in these areas and though the idea of nursery origin was a reasonable conclusion in the case noted in July, it does not serve to account for all the cases.

Description of the Bug.—The adult female bug is an oval purplish brown insect densely clothed with a white mealy secretion, the largest attaining a length of 6—7mm. ($\frac{1}{4}$ in.). They are provided with legs but are not very active, once they have reached the adult stage. Reproduction is by means of eggs which are oval, pale yellow and about ·3 mm. long. A single female may lay from 350 to 650 eggs in her lifetime. The eggs remain in clumps surrounded by meal behind the female, who moves a small distance forward to rid herself of the brood, and make room for fresh batches. The eggs hatch in 2—4 days and the young bugs become active 2 or 3 days after emergence and move about to find suitable feeding places. The complete life cycle is in the course of being investigated.

Habits.—The bugs show themselves to be extremely averse to light and this appears to be the reason for their subterranean existence. They can be "acclimatized" to the ærial portions of plants if these are kept in the dark. Occasionally old bugs are found some distance up the stems of *Erythrina* but smaller ones are never found in this situation. It may be taken as certain that Mealy bugs found above soil belong to different species or at least different races and need no further consideration in the problem. The old bugs occasionally found above ground have ceased to lay eggs and are therefore of little further practical importance.

The bugs show rather more activity than is usual with members of this group, but the distances moved are, as a rule, not very great. The period of greatest activity is in

the early stages, when the young are moving away from the egg masses to find suitable spots for feeding.

They are very widely distributed in the soil in the areas where investigations are proceeding. They occur free in the soil on weeds and especially on the roots of *Erythrina* and on the under sides of *Erythrina* loppings lying on the ground. They are not found in soils very deficient in organic matter or where there is an excess of water. In depth, they are to be found down to about a foot.

Nature of Damage.—Their ability to cause damage has been established experimentally. The bugs extract nourishment by sucking material from the cortical regions of the attacked roots. The injury seems at first to stimulate growth and this results in the bugs becoming partly enclosed in hollows surrounded by spongy cellular tissue. The presence of large numbers of bugs all sucking material and encouraging local attempts at callusing at points of injury constitutes a serious drain on the resource of the young plant. The points of injury also provide areas of weakness prone to act as points of entry for the penetration of various rotting organisms. At the same time, young plants with well developed root systems do not seem to suffer very seriously even when bugs are present.

Associated Organisms.—The bugs are attended by the cocktailed and the common red ant. The role they play in connection with the bug remains for further investigation.

A beetle as yet un-identified has been reared from larvæ found among the bugs, upon which the larvæ appear to feed. This insect will also receive further study.

Treatments.—Pot experiments to study the treatments which have been applied in estates and variously reported upon have been started but results are not yet available.

Cockchafer.—The investigations were started with a preliminary survey of the situation in July 1931. A number of pits were dug in various parts of an estate which had suffered very heavy losses of young plants and the number of Cockchafer grubs found was recorded. From 10 pits, 1 yard square and at least 2 feet deep, 44 grubs were recovered, an average of 4·4 per square yard. A further 40 plants were removed to study the condition of the root systems and an area of about 18 inches square

and 1 to 1½ feet deep was excavated at the same time. Twenty grubs were found in these pits, but only three were in close association with the root systems and one of these was dead. In the case of the ten larger pits, the grubs were in no way concentrated around the coffee roots.

Judging by the large numbers of grubs collected by the coolies engaged in cultivation, there was a high soil population of such grubs. At the same time, no direct evidence of their actually attacking the coffee was obtained. At the time it was considered probable that they were one cause of the great losses of young plants but by no means the only one.

A considerable number of sickly plants were then examined. The usual features were a bitten and gnawed appearance of the tap root, absence of lower laterals and a profuse development of young adventitious roots at the soil level. The lower part of the tap root was usually rotting, but no constant features were present to suggest a fungus disease. The level of the main damage was below the level in which the grubs were most plentiful in July, and it appeared as if the causes of damage must have acted earlier.

The results of this preliminary inspection were summarized as follows:—

1. The grubs were not actually attacking the coffee during July.
2. During July, the grubs are mainly in the top 6 inches of the soil which is above the level of the damage on the coffee plants.
3. There is no concentration of grubs around the coffee.
4. General conditions do not seem to favour supplies and the number of malformed root systems is high.

Some observations were made on the characters of the grubs. They are of the typical Cockchafer type, being greyish white grubs usually bent in to a U shape, provided with stout walking legs, a strong brown head capsule and large biting mouth parts. They fall into three main size groups, the largest being about 1½ inches in length. The size groups are not clear cut but the examination of the head capsules suggested that clearly marked stages

could probably be distinguished with their help. No decision as to the number of species involved was arrived at.

Some grubs were put in boxes filled with soil and when these were protected from rain and the surface layers allowed to dry, it was found that the grubs descended to the bottom of the box. Like a number of other Cockchafer grubs their movements in the soil are probably determined by the soil moisture. Applications of Tobacco waste, such as have been in use as a repellant on the estates concerned, to boxes in which grubs were placed seemed to have no effect but the experiment was not very satisfactory. The excavating of a pit filled afterwards with cattle manure in the centre of a box in which a number of grubs were placed at random did not show any marked movement of grubs into the manure. Unfortunatelyt he death rate of the grubs in the boxes was very high.

Work was commenced on the problem by the Assistant Entomologist in February 1932. The first problem was the situation of the grubs during the dry weather. It was considered that they were likely to be very deep in the soil, so the pits were excavated to a depth of 5—6 feet. Forty such pits were dug in 4 estates where the grubs were found in large numbers during the previous monsoon. They were made around sickly plants, in damp spots and around tree stumps and some pits were watered and left for several days. The total number of grubs found was 10, of which 8 were enclosed in mud cells. This result is extremely surprising, and more so, as some plants taken out had fresh injuries of the type attributed to the grubs and which obviously could not have been caused by them.

Attention was then turned to sickly plants and about 200 such plants were carefully dug up and examined. They showed in general poor root development, the production of adventitious roots at the collar and a high proportion of malformed tap roots.

The first adult Cockchafer beetles were seen on March 9th and from about the 15th the numbers seen began to increase. It remains unknown whether these beetles originated in the estates themselves or came in from outside areas. Two kinds of adult beetles were seen, one brown backed and the other grey backed, the latter being found over a shorter period than the former.

The principal food plants were determined as *Erythrina*, Atti, (*Ficus glomerata*) and *Albizzia odoratis-*

sima. Light traps were found ineffective in catching the beetles, but considerable numbers could be caught by hand in the evening. Further work to investigate the life history of these beetles is planned for the future.

At present, it is of course too early to draw any conclusions but the evidence so far collected leaves the part played by Cockchafer grubs extremely obscure.

The possibility of the damage to young plants being due to Nematode worms has been considered. Examination of a number of sickly plants revealed the presence of Nematode worms in the decaying cortical tissues, but that they play any primary part seemed unlikely. Further observations on this point will be made in the future.

Work will be continued at the Field Station at Sidapur where the Assistant Entomologist has been stationed.

General Remarks.

The year 1931-32 commenced favourably with (on the whole) adequate and seasonable blossom showers. The monsoon was rather late in starting and after a mild beginning in June and July, developed into an extremely heavy in August. Losses from Black Rot were severe in unsprayed areas where facing and situation favoured the disease. Leaf Disease was however somewhat checked by the constant heavy rain in August. The lighter rainfall conditions of the earlier part of the monsoon had favoured it, but the net effect was to reduce slightly the attacks of the disease in October. During the N. E. monsoon, coffee generally looked in extremely good condition, especially in sprayed areas.

Crops turned out badly, particularly in Mysore and certain parts of Coorg owing to the high percentage of black bean and to losses due to the rain in December.

The December rain was most unfortunate. Besides, a great deal of ripe fruit fall, it gave a fresh impetus to Leaf Disease and at the same time, caused a great deal of new shoot formation at nodes which should have produced flower bud. In spite of this, the general condition of coffee in the early part of 1932 was good and only in a few small areas was there any rain before the end of March.

These remarks apply more particularly to Mysore but reports from other districts followed the same general lines.

Diseases.—Leaf and Shoot Diseases.—In addition to Leaf Disease (*Hemileia vastatrix*) and Black Rot (*Corticium koleroga*), the only other disease of leaves or shoots which came into prominence during the year was Pink Disease (*Corticium salmonicolor*). It hardly reached formidable proportious anywhere but was considerably more noticeable than in previous years. The disease can be recognized by the wilting of branches and the blackening of the fruit at the joints of such branches. Close inspection reveals a very fine fungus web on the under side of affected branches and this extends over affected fruit. On the fruit and to some extent on the branches, the fungus forms little white clumps of threads which are visible to the naked eye. The fungus does not appear to extend on to the leaves but these droop and eventually fall as a result of the attack on the branches. It is a common disease affecting a wide variety of plants, including tea, rubber, citrus fruits, silver oak and numerous other forest and shade trees. It does not seem to constitute a serious pest of coffee. The presence of the disease in 1931, was no doubt, due to the abnormally wet conditions of the latter part of the monsoon. It is amenable to spraying and should not develop seriously on sprayed coffee. Affected branches should be cut out and burned.

One or two minor undetermined leaf spot diseases were reported during the year but they were not sufficiently serious to call for special control measures.

In nurseries, Collar Rot due to *Rhizoctonia solani* was occasionally reported. Recommendations for the control of this disease were made in the report of 1930-31.

Hemileia Vastatrix has been noted occasionally on certain Robusta plants and I am of the opinion that such susceptible plants should be removed and fresh supplies put in or stumped and grafted with a non-susceptible strain. So far, there seems no cause for alarm that Robusta will succumb to Leaf Disease in the same way as Arabica, and experience in Java strengthens this view. At the same time, the existence of physiological strains and the possibility of the development of a Robusta attacking strain makes it desirable that susceptible plants should be removed. In any case, these plants are usually unthrifty specimens and replacement would be desirable on general grounds.

Root Diseases.—The records under Root Diseases have

been dealt with in a previous section. Root Diseases are only exceptionally acute in coffee, though most estates have some areas from which trees are lost year after year, a loss which in estate work is usually classed with the greater losses due to borer.

Insect Pests.—Borer.—Stem borer (*Xylotrechus quadripes*) still constitutes the most serious insect pest. No work on the problem has been carried out by the Scientific Officer, but the matter is under investigation by the Entomological Section of the Mysore Department of Agriculture. There are one or two cursory observations made however which deserve recording. There have been a number of cases of bored trees examined in March-April which suggest that there is a fairly considerable March brood of adult beetles, in addition to the October brood. It seems desirable that removal of bored trees should be done in two rounds, one before this March flight as well as one in the monsoon. The difficulty of burning plants removed in March is considerable owing to the risk of fire but it is highly desirable that the grubs and adults should be destroyed, before the flight occurs.

Bugs.—These have been locally serious and the delay in the commencement of the S. W. monsoon in 1931 aggravated the trouble. Spraying (or brushing when young plants are attacked) with Fish Oil Resin Soap remains the only treatment which checks the attacks.

Minor insect pests include Cut worms, Red Borer (*Zeuzera coffeæ*) and grasshoppers. The last type of pest caused a slight alarm on one estate in Coorg where a number of promising young plants had their tops badly damaged by the deposition of eggs in the tissues of the green shoots. The number of plants attacked remained small and after the removal and destruction of the damaged portion, no further trouble was experienced. The adults which laid the eggs were not seen.

Correspondence and Publications.

Enquiries have been on the increase during the year. The largest proportion have been in connection with spraying problems and these have been dealt with on the basis of experience at the Experiment Station and elsewhere. Manuring enquiries occupy second place and these have been treated on the basis of the experience of the

Experiment Station and of the Chemical Section of the Mysore Department of Agriculture.

A bulletin on "The Seasonal Periodicity of Coffee Leaf Disease. Second Report" was published as bulletin No. 6 of the Mysore Government Coffee Experiment Station. Three articles, "Spraying and Dusting for Coffee Leaf Disease," "Observations on Spraying Experiments" and "Die Back of Coffee" were published in the "Planters' Chronicle" during the year. A short technical note on "The Existence of Physiological Specialization in *Hemileia vastatrix B. & Br.*" was sent to "Nature."

Acknowledgments.—I have to express my very great appreciation for the continued cordial advice and assistance which has been given me at all times by Dr. Coleman and his staff both at the Coffee Experiment Station and at Bangalore.

My thanks are also due to the many planters who have, from time to time, assisted me in various phases of the work here recorded. The work of the Assistant Entomologist in the short period since his engagement has amply repaid his appointment. The greater part of the account of Cockchafer and Mealy Bug are based on his reports. Distinct progress in this problem during the coming year is certain.

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